REPORT 39

[redacted]

SWEEP

SOIL AND WATER

ENVIRONMENTAL

ENHANCEMENT PROGRAM

PAMPA

PROGRAMME D'AMELIORATION

DU MILIEU PEDOLOGIQUE

ET AQUATIQUE

Canada

Ontario

## SWEEP

*is a $30 million federal-provincial agreement, announced May 8, 1986, designed to improve soil and water quality in southwestern Ontario over the next five years.*

## PURPOSES

*There are two interrelated purposes to the program; first, to reduce phosphorus loadings in the Lake Erie basin from cropland run-off; and second, to improve the productivity of southwestern Ontario agriculture by reducing or arresting soil erosion that contributes to water pollution.*

## BACKGROUND

*The Canada-U.S. Great Lakes Water Quality Agreement called for phosphorus reductions in the Lake Erie basin of 2000 tonnes per year. SWEEP is part of the Canadian agreement, calling for reductions of 300 tonnes per year — 200 from croplands and 100 from industrial and municipal sources.*

## PAMPA

*est une entente fédérale-provinciale de 30 millions de dollars, annoncée le 8 mai 1986, et destinée à améliorer la qualité du sol et de l'eau dans le Sud-ouest de l'Ontario.*

## SES BUTS

*Les deux buts de PAMPA sont: en premier lieu de réduire de 200 tonnes par an d'ici 1990 le déversement dans le lac Erie de phosphore provenant des terres agricoles, et de maintenir ou d'accroître la productivité agricole du Sud-ouest de l'Ontario, en réduisant ou en empêchant l'érosion et la dégradation du sol.*

## SES GRANDES LIGNES

*L'entente entre le Canada et les États-Unis sur la qualité de l'eau des Grands Lacs prévoyait de réduire de 2 000 tonnes par an la pollution due au phosphore dans le bassin du lac Erie. PAMPA fait partie de cette entente qui réduira cette pollution de 300 tonnes par an — 200 tonnes provenant des terres agricoles et 100 tonnes provenant de sources industrielles et municipales.*

100-05393/

TECHNOLOGY EVALUATION AND DEVELOPMENT SUB-PROGRAM

# REPORT ON "TYE-DRILL" MODIFICATIONS FOR SOWING SOYBEANS ON COMMERCIAL FARMS UNDER NO-TILL CONDITIONS

FINAL REPORT

January, 1992


| | |
|---|---|
| Prepared by: | SOUTHWESTERN ONTARIO AGRICULTURAL RESEARCH CORPORATION (SWOARC)<br>Harrow, Ontario |
| Under the Direction of: | ECOLOGICAL SERVICES FOR PLANNING LIMITED,<br>Guelph, Ontario - Subprogram Manager For TED |
| On Behalf of: | AGRICULTURE CANADA<br>RESEARCH STATION,<br>HARROW, ONTARIO N0R 1G0 |


Disclaimer: The views contained herein do not necessarily reflect the views of the Government of Canada or the SWEEP Management Committee.

Recycled Paper

Papier recyclé

## Study Team

1. Jack Rigby, Project Manager, Cooperator
2. Henry DeBrouwer, Cooperator
3. Pete and Herb Groenewegen, Cooperators
4. Dan Myslik, Cooperator
5. Peter Cumming, Cooperator
6. Jo Muehmer, Advisor and Author
7. Linda Hutchins. Office Manager


## ACKNOWLEDGEMENTS

The Southwestern Ontario Agricultural Research Corporation sincerely thanks the Study team for their faithful attention to the execution of this study, the keeping of records and participation in the evaluation of the results.

Special thanks are also extended to the agencies and individuals who contributed to this study, namely:

1. The Scientific Authority, Dr. W. I. Findlay, Agriculture Canada, Research Station, Harrow, Ontario.
2. Ecological Services for Planning, TED-subprogram Manager, Guelph, Ontario.
3. Anne Marie Hedrick and Angela Myslik, technical staff, without whose assistance this study would not have been possible.

## Executive Summary

In 1988, a study was initiated by a group of farmers in Rondeau Bay area of Kent County. The goal of the study was determine if more aggressive and better matched coulter/presswheel combinations would improve the performance of the Tye drill for narrow row planting of soybeans in a no-till system. Experiments with the Tye drill in previous years had shown a tendency for poor seed establishment due to non-uniform seed depth, resulting in the exposure and desiccation of the seed.

In year one of the study, side by side comparisons of crop performance were made for fields planted with the Tye drill and with conventional planting units. The Tye drill was outfitted on one side with a bubble coulter and two V-presswheels with 8" rows, and on the other side with a fluted coulter and a single presswheel.

The results of the first year of research were inconclusive, due in part to the drought of 1988. While plant populations at two of the five sites were significantly higher on fields planted with the Tye drill compared to the conventional planter, the differences in yields were not significant.

The study continued in 1989 using the same comparisons as in Year 1, with some additional treatments. The Tye drill equipped with 1" fluted coulters across the front was outfitted on the left half portion of the drill rows with single presswheels while the other half had standard V-type (double) presswheels. On demand, a rake could be dropped behind the full width of the drill. It was

hoped that one of these combinations would provide a more favourable seedbed environment, which would translate into greater emergence and yields.

The results of the 1989 field season were not encouraging for any of the Tye drill treatments. At all of the sites, plants seeded with conventional planters experienced more rapid and vigorous emergence when compared to all other treatments. At all but one of the sites, the yield on the plot that was planted with the conventional planter was greater than any of the corresponding yields from the Tye drill treatments.

The results of two years of experiments with the Tye drill were not conclusive. The farmers who were involved in the study are still interested in making minor adjustments to the coulters of the Tye drill in an effort to improve the seed placement. They would also like to evaluate the performance of the Tye drill on a field scale. There was some feeling amongst the farmers involved in the research, that the plot scale research may have introduced errors and biased the results in favour of the planters.

**TABLE OF CONTENTS**

1.1 Introduction . . . . . 1
1.2 Field Study Objectives . . . . . 2
2.0 Materials and Methods . . . . . 2
2.1 Soil Types . . . . . 4
2.2 Equipment and Machinery . . . . . 4
2.3 Treatments (Year 1) . . . . . 7
2.4 Plot Layout (Year 1) . . . . . 7
2.5 Treatments (Year 2) . . . . . 8
2.6 Plot Layout (Year 2) . . . . . 9
3.0 Recording Data . . . . . 10
4.0 Results and Discussion (Year 1) . . . . . 13
4.1 Population . . . . . 13
4.2 Yields . . . . . 14
4.3 General Observations (Year 1) . . . . . 15
5.0 Results and Discussion (Year 2) . . . . . 17
5.1 Population and Emergence . . . . . 18
5.2 Plant Height . . . . . 21
5.3 Pod Count and Plant Disease . . . . . 22
5.4 Yields . . . . . 23
5.5 General Observations (Year 2) . . . . . 24
6.0 Conclusions and Recommendations . . . . . 25
6.1 The Farmers' Report . . . . . 26
7.0 Appendices . . . . . 27

## LIST OF FIGURES


Figure 1 Location of the field plots for the 1988 and 1989 Tye drill experiments . . . . . 3

Figure 2 Tye drill - Arrangement with Bubble Coulters and Standard V-type Presswheels . . . . . 5

Figure 3 Tye drill - Arrangement with Fluted Coulters and Single Presswheels . . . . . 5

Figure 4 Tye drill - Trailing Rake/Harrow Option . . . . . 5

Figure 5 John Deere - 7000 Maximerge Planter Arrangement . . 6

Figure 6 New Idea - Kinze Planter Arrangement . . . . . 6

Figure 7 New Idea - Kinze (double frame) Planter Arrangement 6


## LIST OF TABLES


Table 1 Field Conditions for the 1988 Tye drill Soybean Experiment . . . . . 8

Table 2 Field Conditions for the 1989 Tye drill Soybean Experiment . . . . . 9

Table 3 1988 Rainfall Data . . . . . 11

Table 4 1989 Rainfall Data . . . . . 12

Table 5 1988 (Year 1) Soybean Populations (Plants/$m^2$) . . . 13

Table 6 1988 (Year 1) Soybean Yields (Bu/acre) . . . . . 14

Table 7 Tye Drill Modifications 1989 - Total Emergence /$m^2$ 18

Table 8 Tye Drill Modifications 1989 - Harvest Population - Plants/$m^2$ . . . . . 18

Table 9 Soybean Emergence (Pl. Count/$m^2$) RIGBY . . . . . 19

Table 10 Soybean Emergence (Pl. Count/$m^2$) DEBROUWER . . . . 20

Table 11 Soybean Emergence (Pl. Count/$m^2$) GROENEWEGEN . . . 20

Table 12 Soybean Emergence (Pl. Count/$m^2$) MYSLIK . . . . . 21

Table 13 Soybean Emergence (Pl. Count/$m^2$) CUMMING . . . . . 21

Table 14 Tye Drill Modifications 1989 - Plant Height cm . . 22

Table 15 Tye Drill Modifications 1989 - Pod Count /$m^2$ . . . 22

Table 16 Tye Drill Modifications 1989 - Root Rot - Diseased Plants/$m^2$ . . . . . 23

Table 17 Tye Drill Modifications 1989 - Yields (Bu/acre) . . 24

## 1.1 Introduction

One of the goals of the Technology Evaluation and Development (TED) subprogram of SWEEP is to involve the farming community in the process of developing technologies and management systems. This results of such research will be directly applicable to the needs of farmers in their quest for improved soil conservation practices. Widespread adoption of these technologies is essential if SWEEP is to reach its phosphorus reduction goals within the specified time frame.

It is desirable to hasten the adoption process, for soybean growers especially. Thus, the expertise of progressive, innovative farmers was utilized on a number of representative soils in this region which are subject to sediment and phosphorus movement.

The Rondeau Bay group of farmers in Kent County has expressed concern about the unsatisfactory performance of the conventionally equipped Tye drill for close planting of soybeans in a reduced tillage system. The problem is perceived by farmers to be inadequate seed coverage, due to uneven depth placement of seed resulting in seed exposure and desiccation. Several farmers have made various adjustments to the equipment but have not improved its performance to a satisfactory level.

In 1988 (Year 1) this group of farmers attempted to obtain a solution to the problem through close comparisons of various coulter press wheel combinations at different plant spacings. In 1989 (Year 2), further studies on the coulter wheel combinations were conducted, with additional treatments added to investigate the effect of a trailed rake or harrow behind the drill.

## 1.2 Field Study Objectives

The demonstration/research plots were located on the properties of five farmer cooperators in both years of the study. The objective of the Year 1 study was to determine whether the use of more aggressive and better matched coulter/packing wheel combinations for narrow spacings would improve the performance of the Tye drill for planting soybeans in a no-till system. At the same time it was intended to measure the performance of the Tye drill against conventional corn planting units, which are limited to wide row spacings.

The Year 2 study objectives were the same as those of Year 1, with some additional objectives aimed at fine-tuning the system. The study participants wished to determine if single or double V presswheels, in combination with a rake, could effectively level the seed bed and/or part the corn trash, concurrently facilitating and improving coverage of the drill row.

## 2.0 Materials and Methods

Location: The field plots of the grower/cooperators were located in the Township of Harwich, County of Kent (Figure 1). Cooperators 1,2,4, and 5 listed below participated in field tests in both 1988 and 1989. Cooperator 6 participated in the 1988 research season and was replaced by cooperator 3 in the 1989 season.

| | | |
|---|---|---|
| 1. | Jack Rigby, principal manager | Con. 3, Lot 17 (1988)<br>Lot 16 (1989) |
| 2. | Henry DeBrouwer | Con. 3, Lot 22 |
| 3. | Groenewegen Bros. | Con. 2, Lot 22 (1989 only) |
| 4. | Dan Myslik | Con. 5, Lot 16 |
| 5. | Peter Cumming | Con. 3, Lot 14 |
| 6. | Arthur Huffman | Con. 3, Lot 14 (1988 only) |

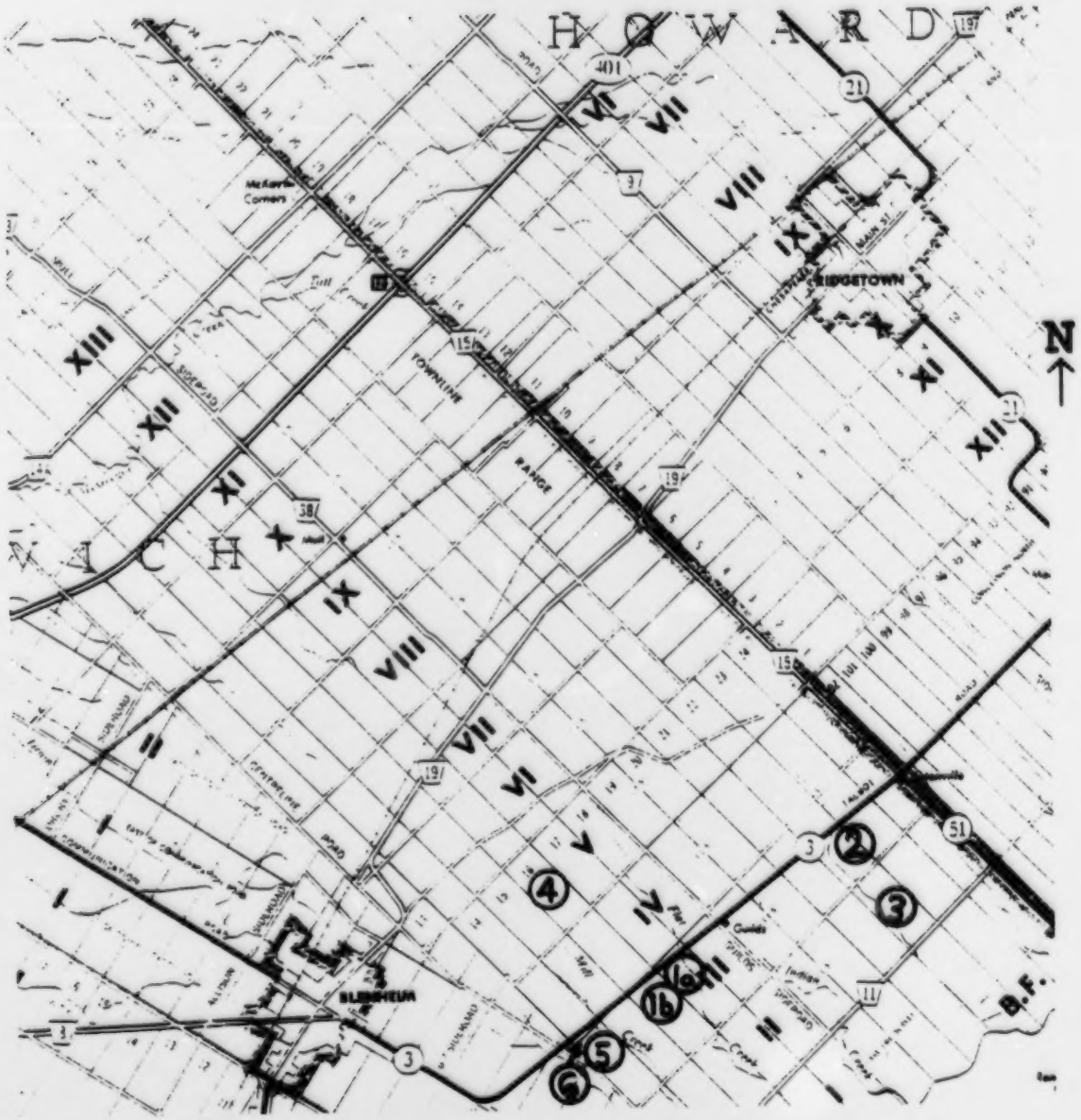


Figure 1. Location of the field plots for the 1988 and 1989 Tye drill experiments

Farmer Cooperators
1a = Jack Rigby (1988)
1b = Jack Rigby (1989)
2 = Henry DeBrouwer
3 = Groenewegen Brothers (1989 only)
4 = Dan Myslik
5 = Peter Cumming
6 = Arthur Huffman (1988 only)

## 2.1 Soil Types

The farms of cooperators 1,2,5 and 6 are located on a Haldimand loam soil. The farm of cooperator 3 is located on a Haldimand clay loam, while cooperator 4 is situated on a somewhat sloping Fox gravelly loam.

## 2.2 Equipment and Machinery

The same Tye drill was used by all of the cooperators. It had a coulter/caddy front bar set for 22 rows at an 8" row spacings and a trailing hoistable rake in two sections attached to the frame. The Tye drill arrangements used in the 1988 and 1989 field experiments are shown in Figures 2, 3 and 4.

The following planters (check) were used for comparisons with the Tye drill at the five locations:

| | | | | | |
|---|---|---|---|---|---|
| 1. | Rigby | John Deere-7000 Maximerge | | 12 rows | Fig. 5 |
| 2. | DeBrouwer | John Deere-7000 Maximerge | | 12 rows | Fig. 5 |
| 3. | Groenewegen | New Idea-Kinze | | 5 rows | Fig. 7 |
| 4. | Cumming | New Idea-Kinze | Year 1 | 7 rows | Fig. 6 |
| | | | Year 2 | 9 rows | " |
| 5. | Myslik | New Idea-Kinze | Year 1 | 7 rows | Fig. 6 |
| | | | Year 2 | 9 rows | " |
| 6. | Huffman | New Idea-Kinze | | 7 rows | Fig. 6 |

The planter configurations are shown in Figures 5, 6 and 7.

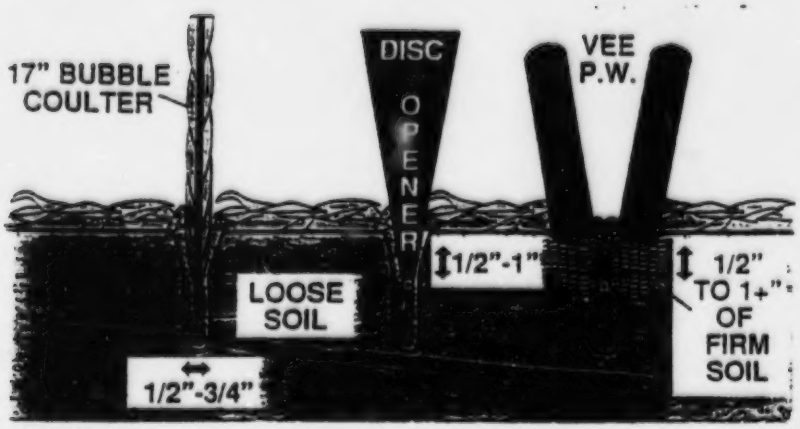


Figure 2. Tye drill - Bubble Coulter and Standard V-type Presswheel Arrangement

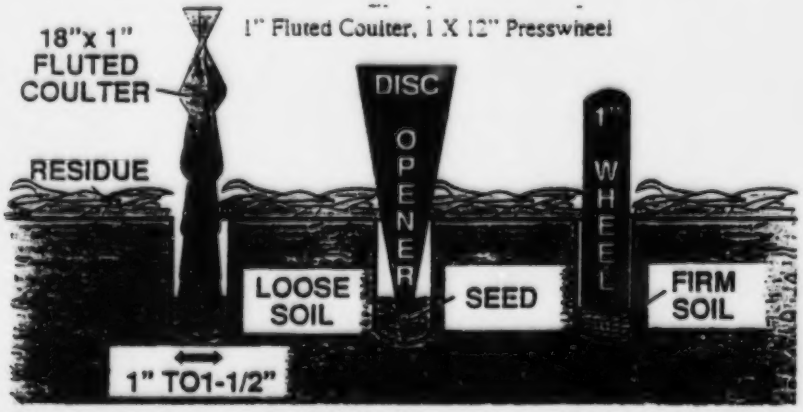


Figure 3. Tye drill - Fluted Coulter and Single Presswheel Arrangement

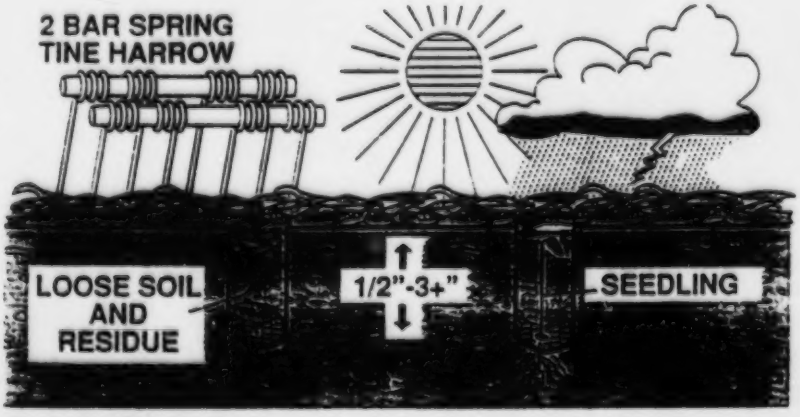


Figure 4. Tye drill - Trailing Rake/Harrow Option (the above figures obtained from promotional materials published by the Tye Company, P.O. Box 218, Lockney, Texas 79241)

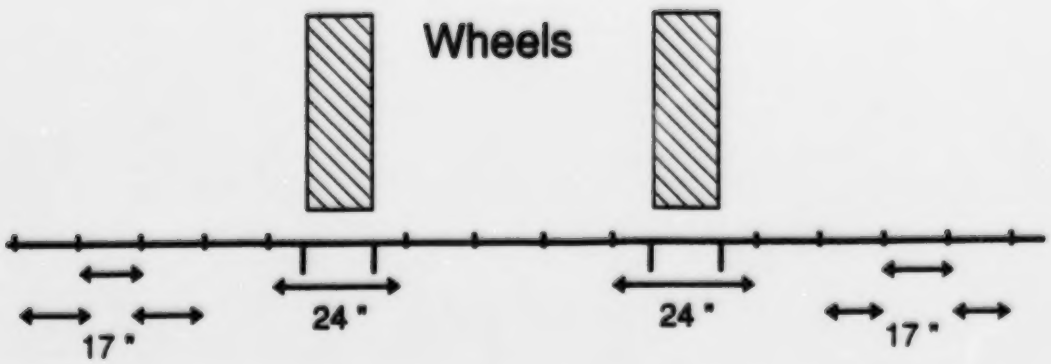


Figure 5. John Deere - 7000 Maximerge Planter Arrangement

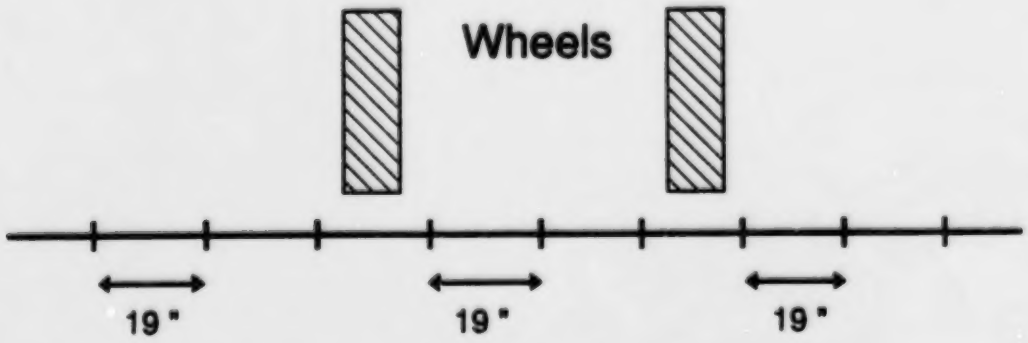


Figure 6. New Idea - Kinze Planter Arrangement

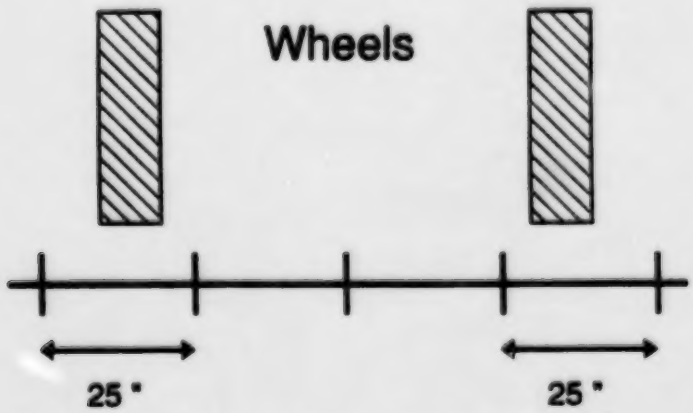


Figure 7. New Idea - Kinze (double frame) Planter Arrangement

**2.3 Treatments (Year 1)** (planter/coulter/presswheel arrangements)

1. Tye drill with bubble coulter and V-presswheels (2) with 8" rows (Figure 2).
2. Tye drill with 18" x 1" fluted coulter (Tye #555-318) and E-Z adjust single presswheel (Tye #204-303) with 8" rows (Figure 3).
3. John Deere planter with two 1" fluted coulters and standard V-type presswheels with 17" rows.
4. New Idea planter with two 2" fluted coulters and standard V-type presswheels with 19" rows.

(see photos in Appendix C)

The changes in the coulter/presswheel combination on the Tye drill were always made in the centre portion of the planter unit. Details about the planter arrangement and agronomic practices at each of the sites in Year 1 are presented in Table 1.

**2.4 Plot Layout (Year 1)**

On each location and approximately in the centre of the field, at least one planting round was executed with the Tye drill next to the conventional planter. In several instances, half the field was planted with each particular planter. For every treatment, four replications of 15 metres (50 feet) were selected at random from the field-length strips and flagged for subsequent measurements.

Soybeans were planted from May 12 to May 24, 1988 into unincorporated corn stalks from the previous year, except for cooperator Art Huffman who planted into soybean stubble. Harvest

was started October 1 and completed during the last week of October.

TABLE 1 Field Conditions for the 1988 Tye drill Soybean Experiment

| Cooperator | Rigby | DeBrouwer | Myslik | Cumming | Huffman |
|---|---|---|---|---|---|
| Previous Crop | Corn | Corn | Corn | Corn | Soybeans |
| Planter (for comparison) | John Deer-Maximerge 12 row | John Deer-Maximerge 12 row | New Idea-Kinze 7 row | New Idea-Kinze 7 row | New Idea-Kinze 7 row |
| Planter Row Width | 17 in. | 17 in. | 19 in. | 19 in. | 19 in. |
| Soybean Cultivar | Jewel | Elgin | P.9202 | Jewel | Jewel |
| Planting Date | May 14, 1988 | May 12, 1988 | May 14, 1988 | May 21, 1988 | May 24, 1988 |
| Herbicide | 2-4-D Dual Senicor | Roundup-Pre Dual Lexone (.4 Kg/ha) | Roundup-Pre Sencore Poast Basagran | Dual + Ambien | Dual Lexone (.5 Kg/ha, 2.5 oz 2-4-D) |

**2.5 Treatments (Year 2)** (planter/coulter/presswheel arrangements)

1. The Tye drill equipped with 1" fluted coulters across the front was outfitted on the left half portion of the drill rows with single presswheels while the other half had standard V-type (double) presswheels. On demand, a rake could be dropped behind the full width of the drill (Figure 4).

2. The configurations of the planters used for comparison with the Tye drill are shown in Figures 5 to 7. The John Deer Maximerge planter (Figure 5) was equipped with two 1" fluted coulters and standard V-type presswheels (double). Both of the New Idea-Kinze planters (Figures 6 and 7) were equipped with two 2" fluted coulters and standard V-type presswheels (double).

Details about the planter arrangement and agronomic practices at each of the sites in Year 2 are presented in Table 2.

TABLE 2 Field Conditions for the 1989 Tye drill Soybean Experiment

| Cooperator | Rigby | DeBrouwer | Groenewegen | Myslik | Cumming |
|---|---|---|---|---|---|
| Previous Crop | Corn | Corn | Corn | Corn | Corn |
| Planter (for comparison) | John Deer-Maximerge 12 row | John Deer-Maximerge 12 row | New Idea-Kinze 5 row | New Idea-Kinze 9 row | New Idea-Kinze 9 row |
| Planter Row Width | 17 in. | 17 in. | 25 in. | 19 in. | 19 in. |
| Soybean Cultivar | Jewel | Jewel | Jewel | Jewel | Jewel |
| Planting Date | May 28, 1989 | May 29, 1989 | May 30, 1989 | June 11, 1989 | June 10, 1989 |
| Harvest Date | Oct. 12-13, 1989 | Oct. 13, 1989 | Oct. 16, 1989 | Nov. 13, 1989 | Oct. |
| Fertilizer | none | 16/A 0-0-90 | none | 16/A 10-57.5-45 | none |
| Herbicide | pre/roundup dual/poast senicor | pre/roundup dual lexone | pre/roundup dual lexone | pre/roundup senicor poast | dual roundup ambien |

## 2.6 Plot Layout (Year 2)

Near the centre of the soybean field at each location, at least two planting rounds were executed with the Tye drill in order to have each half portion repeated side by side and thereby doubling the specific treatment in either case, i.e. twice eleven (11) rows with single presswheel units next to twice eleven (11) rows with double V-type presswheel units. Approximately halfway through the length of each field plot, the rakes were dropped, superimposing an additional seed covering treatment on the experiment (Figure 4). In each location the Tye drill treatments

were "framed" and placed next to rows sown with a conventional corn/soybean planter. For every treatment at each location, four replications of 25 m (50 feet) were selected at random from the large field-length strips and flagged for subsequent measurements during the field season.

Soybeans were planted from May 28 to June 11, 1989 (Table 2) into unincorporated corn stalks left on the surface of the ground from the previous crop. Harvest was started on October 12 and completed on November 13. The crop harvested on November 13 also had the latest planting date (June 11) and had been hit by an early frost on September 24, hastening the maturation process.

## 3.0 Recording Data

1. Emergence: Year 1 emergence data were collected on the following schedule: 3x daily after first showing followed by
3x every second day, then
3x every fourth day (last count = final stand)

In Year 2, the emergence data collection schedule was modified as follows:

5 sites, 2 x daily after first break through, then
5 sites, 2 x every record day
3 sites, 1 x after 3 days
3 sites, 1 x after 4 days
4 sites, 1 x after 5 days (last count = final stand)

In general, counts were taken whenever emergence patterns warranted a seedling count.

2. Yields: On both Year 1 and Year 2, bean yields were obtained using a "Hegie" plot combine, with a 1 m (40") cutting head. Whole plot yields were bagged, to be cleaned and weighed and grain

moisture determined at a later date. Grain moisture was estimated using a Dickey-john GAC II moisture meter.

3. The following additional physiological data were obtained approximately 3 days before harvest on Year 2 of the experiment only:
   a) plant population - plants/$m^2$
   b) pod count - number of axils with 3 pods or more
   c) root rot - diseased plants/$m^2$

4. Rainfall: Recorded at each site by the cooperator. Daily rainfall accumulations in Year 1 are shown on Table 3, while the Year 2 rainfall accumulations are shown in Table 4. In Year 2, Myslik's rainfall data were unavailable after August 1st.

TABLE 3 1988 Rainfall Data (mm)

| Cooperator | | Rigby | DeBrouwer | Myslik | Cumming | Huffman |
|---|---|---|---|---|---|---|
| May | 15 | 23.0 | 23.0 | 23.0 | | |
| | 22 | 2.5 | | | | |
| Jun | 1 | 6.4 | 15.2 | 7.6 | 7.6 | 7.6 |
| | 3 | | 2.5 | 2.5 | | |
| Jul | 10 | 7.6 | 4.0 | 7.6 | 7.6 | 7.6 |
| | 16 | 30.5 | 37.0 | 33.0 | 33.0 | 33.0 |
| | 18 | 22.9 | 12.0 | 16.5 | 22.9 | 22.9 |
| | 27 | 12.7 | 5.0 | 10.0 | 9.0 | 9.0 |
| Aug | 5 | 17.8 | 18.0 | 15.0 | 12.5 | 12.5 |
| | 11 | 2.5 | 1.0 | 7.6 | 4.5 | 4.5 |
| | 14 | 5.0 | 4.0 | 7.6 | 7.0 | 7.0 |
| | 23 | 3.8 | 6.0 | | 5.0 | 5.0 |
| | 24 | | 5.0 | | | |
| | 28 | 12.7 | 12.0 | | 12.5 | 12.5 |
| Sep | 4 | 33.0 | 39.0 | | 33.0 | 33.0 |
| | 12 | | 10.0 | | | |
| | 19 | | 8.0 | | | |
| Totals | | 180.4 | 201.7 | 130.4 | 154.6 | 154.6 |

| TABLE 4 1989 Rainfall Data (mm) | | | | | | |
|---|---|---|---|---|---|---|
| Co-operator | | Rigby | DeBrouwer | Groenewegen | Myslik | Cumming |
| May | 30 | 25 | 24 | 23 | 0 | very wet field |
| | 31 | 15 | 25 | 1 | 25 | very wet field |
| Jun | 2 | 5 | 7 | 0 | 25 | very wet field |
| | 4 | 15 | 14 | 5 | 15 | very wet field |
| | 9 | 3 | 3 | 11 | 0 | very wet field |
| | 12 | 6 | 11 | 1 | 15 | 6 |
| | 13 | 3 | 0 | 12 | 0 | 3 |
| | 15 | 0 | 4 | 1 | 0 | 0 |
| | 17 | 8 | 9 | 0 | 9 | 8 |
| | 20 | 36 | 11 | 8 | 6 | 36 |
| | 22 | 8 | 3 | 11 | 8 | 8 |
| | 26 | 13 | 21 | 3 | 13 | 13 |
| | 27 | 3 | 1 | 13 | 3 | 3 |
| Jul | 3 | 13 | 5 | 5 | 15 | 13 |
| | 4 | 0 | 1 | 0 | 0 | 0 |
| | 9 | 0 | 2 | 1 | 5 | 0 |
| | 19 | 8 | 4 | 3 | 13 | 8 |
| | 20 | 13 | 12 | 11 | 20 | 13 |
| | 26 | 5 | 4 | 0 | 46 | 5 |
| | 27 | 0 | 2 | 6 | 0 | 0 |
| Aug | 15 | 5 | 3 | 4 | n/a | 5 |
| | 20 | 0 | 2 | 0 | n/a | 0 |
| | 22 | 18 | 32 | 25 | n/a | 18 |
| | 23 | 3 | 8 | 8 | n/a | 3 |
| | 29 | 28 | 26 | 25 | n/a | 28 |
| Sep | 1 | 10 | 12 | 11 | n/a | 10 |
| | 6 | 15 | 10 | 8 | n/a | 15 |
| | 7 | 3 | 2 | 0 | n/a | 2 |
| | 8 | 5 | 4 | 5 | n/a | 5 |
| | 10 | 0 | 8 | 5 | n/a | 0 |
| | 14 | 17 | 17 | 15 | n/a | 15 |
| | 16 | 5 | 7 | 5 | n/a | 5 |
| Totals | | 288 | 294 | 226 | 218 | 222 |

## 4.0 Results and Discussion (Year 1)

The five cooperators used one of the soybean cultivars Jewel, Elgin or P9202 for all treatments within the comparison plantings (Table 1).

### 4.1 Plant Populations

The plant populations achieved by each grower appeared to be different when compared to their neighbours even where the same drill and coulter assemblies were used (Table 5).

TABLE 5 1988 (Year 1) Soybean Populations (Number of Plants/$m^2$)

| Cooperator | Variety | Tye Drill Bubble Coulter Double V Presswheels | Tye Drill Fluted Coulter Single Presswheel | Check Planter | F Value |
|---|---|---|---|---|---|
| Rigby | Jewel | 22 | 20 | 25 | N.S. |
| DeBrouwer | Elgin | 34 | 38 | 34 | N.S. |
| Myslik | P9202 | 31 | 24 | 19 | N.S. |
| Cumming | Jewel | 52 | 51 | 36 | 6.23* |
| Huffman | Jewel | 73 | 75 | 54 | 12.96** |

* Significant P = 0.05
** Significant P = 0.01

In the case of both Cumming and Huffman, the plant populations achieved with the planter in 19-inch rows were significantly lower than obtained with the Tye drill. It is not clear whether these differences were the result of individual machine adjustment because there are no data on the number of seeds planted.

## 4.2 Yields

The only instances where plant stand affected final grain yield were with Cumming (r=0.724) and Myslik (r=0.521). Myslik's poor initial stand, a victim of the severe consequences of the 1988 drought, was obviously reflected in his lower yields (Table 6).

TABLE 6 1988 (Year 1) Soybean Yields (Bu/acre @ 14% m.c.)

| Cooperator | Variety | Tye Drill Bubble Coulter Double V Presswheels | Tye Drill Fluted Coulter Single Presswheel | Check Planter | F Value |
|---|---|---|---|---|---|
| Rizzy | Jewel | 60.6 | 52.7 | 56.1 | N.S. |
| DeBrouwer | Elgin | 64.4 | 59.8 | 50.4 | 6.42* |
| Myslik | P9202 | 53.1 | 57.3 | 23.8** | N.S. |
| Cumming | Jewel | 59.4 | 56.3 | 43.5 | N.S. |
| Huffman | Jewel | 53.2 | 49.0 | 40.9 | N.S. |

* Significant P = 0.05
** This site was poorly chosen; situated on sloping gravelly loam soil with southerly exposure, explaining the low value for the check plot.

It appears that the high plant populations obtained by Huffman may have been rather detrimental to yields. The field notes indicated a heavy seeding rate. With the other cooperators, no relationships could be established between plant numbers/unit area and crop yields. For future comparisons, emphasis should be placed on more exact calibration of seeding rates, at least within each farm location; better still would be a standardized seeding rate for all cooperators in the project, against which would have to be

measured the extra cost in time and effort to obtain uniformity across all locations.

From the yield summary in Table 6 it becomes apparent that the bubble coulter-1" V-presswheel combination was superior in all, except in one location. This difference, ranging from 4.5 to 15.9 Bu/acre (disregarding the Myslik site) was a surprising and unexpected revelation to all parties concerned. One hopes that 1989 experiments will show similar results under less extreme weather conditions.

**4.3 General Observations (Year 1)**

Three of the sites experienced a downpour of over 20 mm shortly after planting which resulted in severe crusting, and caused erratic and uneven emergence. The rainfall data (see Table 3) appear to support the somewhat higher yields of DeBrouwer; however, it should also be taken into account that this farmer rotates his land with clover, uses pig manure on occasion and generally has a higher organic matter content on this portion of the farm.

The emergence pattern within the row with the check-planter in most locations appeared more uniform to the eye although not necessarily providing higher plant populations as has been noted. The overall yields with the Tye drill using the modification of the 1" fluted coulter with a single 1" presswheel (diameter 10") were generally lower than expected. The original-equipment bubble coulter was extremely hard to align properly with the planting

unit; at the same time the smeared, compressed edges formed by this type of coulter often resulted in seed-placement above the bottom of the seed-furrow causing desiccation.

Despite the unusual weather extremes experienced in 1988, valuable information was collected. Plans for the 1989 trials should take into consideration the problems encountered during the previous season, and should incorporate the necessary changes and improvements, eventually resulting in definite recommendations for the planting of soybeans in narrow row-spacings in a no-till system.

## 5.0 Results and Discussion (Year 2)

In the first year of the study, three different soybean cultivars were used and each farmer cooperator used their planter at its usual seeding rate. In an effort to achieve greater uniformity in the second year of the study, all five cooperators used the Jewel soybean cultivar, at a seeding rate of 80 lb. per acre on all treatments. Using a mechanical balance for the soybeans, each type of planter was calibrated to achieve a seeding rate of approximately 56.5 seeds/$m^2$ (228,615 seeds/acre), to compare as closely as possible to the intended seeding rate of the Tye drill.

The uniformity from planter to planter as well as from field to field was fairly satisfactory from the farmer's point of view. However, Table 7 reveals that several of the Tye drill treatments and all but one of the planter treatments had total emergence values greater than 57 plants/$m^2$, indicating an inconsistent degree of control over the seeding rate. Although the same soybean cultivar was used at all of the sites, differences in soybean seed weights resulted in some variation in the actual seeding rate. Some plots may have received less seeds than intended while others, such as the plots at the Myslik site, probably received more seeds than intended.

Table 7 TYE DRILL MODIFICATIONS 1989
TOTAL EMERGENCE / $m^2$

| COOPERATOR | TREATMENTS 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
|---|---|---|---|---|---|---|
| Rigby | 41.3b | 34.6a | 25.0a | 28.4a | 65.7c | 9.6 |
| DeBrouwer | 56.3b | 49.9a | 54.9a | 48.7a | 73.5c | 6.47 |
| Groenewegen | 45.9a | 55.6b | 60.0c | 57.6b | 66.9d | 3.72 |
| Myslik | 74.6b | 61.2a | 60.0a | 63.1a | 75.6b | 6.54 |
| Cumming | 46.7c | 31.6a | 40.6b | 41.2b | 54.6d | 5.28 |

Values in the same row with different letters are significantly different at the 0.05 probability level

## 5.1 Populations and Emergence

Plant populations at harvest were influenced very little by treatments but differed overall from location to location (Table 8). Similar patterns were evident from emergence counts (Table 7).

Table 8 TYE DRILL MODIFICATIONS 1989
HARVEST POPULATION - PLANTS/$m^2$

| COOPERATOR | TREATMENTS 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
|---|---|---|---|---|---|---|
| Rigby | 31.6a | 31.6a | 33.0a | 27.5a | 51.5b | 10.19 |
| DeBrouwer | 44.7d | 41.0b | 43.5c | 36.9a | 53.3e | 1.02 |
| Groenewegen | 46.7a | 43.9a | 50.0b | 51.8c | 53.5b | 4.23 |
| Myslik | 69.7e | 61.6c | 52.9b | 47.6a | 64.3d | 2.54 |
| Cumming | n/a | n/a | n/a | n/a | n/a | n/a |

Values in the same row with different letters are significantly different at the 0.05 probability level

In almost every instance except for single rake treatment at Myslik's and the no-rake double coulter treatment at Groenewegen's, planter populations were higher than Tye drill populations. Although variations within each field plot and between the different treatments were observed in some locations, no clear pattern developed within any of the cooperator's fields.

Plant emergence counts taken anywhere from four to six times per location gave first evidence that the planters gave more rapid and more vigorous emergence when compared to all other treatments (Tables 9 - 13). From Groenewegen's emergence data (Table 11) one would suspect that the single presswheel/rake combination is the least desirable, but data from the other locations did not support this observation. The pattern at Myslik's differed from the other fields due to the later planting date, which resulted in improved speeds of emergence. This site also showed the least differences between treatments, possibly due to an improvement in climatic conditions favouring more uniform germination/emergence (Table 12).

Table 9 SOYBEAN EMERGENCE (PL. COUNT/m²)

| RIGBY | | TREATMENTS 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
|---|---|---|---|---|---|---|---|
| PLANTED:MAY 28 | | | | | | | |
| JUNE 7 | DAY 10 | 0.68 | 0 | 0.13 | 0 | 0.96 | N.S 3.13 |
| JUNE 8 | DAY 11 | 1.2 | 0.95 | 0.68 | 0.68 | 5.7 | N.S.4.53 |
| JUNE 10 | DAY 13 | 3.2a | 3.0a | 1.6a | 2.3a | 22.1b | 15.75 |
| JUNE 13 | DAY 16 | 12.9a | 7.3a | 5.4a | 6.5a | 45.4b | 26.15 |
| JUNE 16 | DAY 19 | 28.3a | 21.8a | 17.7a | 18.0a | 65.4b | 11.67 |
| JUNE 21 | DAY 24 | 41.3a | 34.6a | 25.0a | 28.4a | 65.7b | 9.60 |

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 10 SOYBEAN EMERGENCE (PL. COUNT/m²)

| DERROUMER | | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
| PLANTED:MAY 29 | | | | | | | |
| JUNE 7 | DAY 9 | 13.5b | 11.8a | 17.5c | 10.4a | 26.2d | 1.46 |
| JUNE 8 | DAY 10 | 19.5a | 23.2b | 25.2c | 19.8a | 38.6d | 1.74 |
| JUNE 10 | DAY 12 | 29.1a | 33.9b | 33.9b | 29.5a | 50.3c | 1.99 |
| JUNE 13 | DAY 15 | 37.4a | 39.7a | 40.1a | 38.8a | 65.2b | 4.05 |
| JUNE 16 | DAY 19 | 51.5b | 47.2a | 52.2b | 45.1a | 71.8c | 4.60 |
| JUNE 21 | DAY 23 | 56.3b | 49.9a | 54.9a | 48.7a | 73.5c | 6.47 |

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 11 SOYBEAN EMERGENCE (PL. COUNT/m²)

| GRONINGEN | | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
| PLANTED:MAY 30 | | | | | | | |
| JUNE 7 | DAY 8 | 2.3a | 8.6a | 10.6a | 17.0a | 21.7b | 8.75 |
| JUNE 8 | DAY 9 | 5.4a | 17.6b | 18.1b | 25.2b | 35.3c | 8.60 |
| JUNE 10 | DAY 11 | 9.6a | 29.8b | 31.2b | 34.3b | 47.8b | 13.5 |
| JUNE 13 | DAY 14 | 22.5a | 43.4b | 42.3b | 43.9b | 58.8c | 12.7 |
| JUNE 16 | DAY 19 | 41.1a | 54.0b | 56.8b | 55.7b | 66.3c | 5.33 |
| JUNE 22 | DAY 23 | 45.9a | 55.6b | 60.0c | 57.6b | 66.9d | 3.72 |

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 12 SOYBEAN EMERGENCE (PL. COUNT/m²)

| MYSLIK | | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
| PLANTED:JUNE 11 | | | | | | | |
| JUNE 19 | DAY 8 | 42.4b | 26.5a | 22.1a | 25.9a | 42.8b | 6.41 |
| JUNE 20 | DAY 9 | 67.1c | 55.5b | 47.4a | 49.0a | 68.3c | 3.95 |
| JUNE 22 | DAY 11 | 73.5b | 60.0a | 58.5a | 58.8a | 75.8b | 8.26 |
| JUNE 27 | DAY 16 | 74.6b | 61.2a | 60.0a | 63.1a | 75.6b | 6.54 |

Values in the same row with different letters are significantly different at the 0.05 probability level

Table 13 SOYBEAN EMERGENCE (PL. COUNT/m²)

| CUMMING | | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
| PLANTED:JUNE 10 | | | | | | | |
| JUNE 19 | DAY 9 | 11.0b | 7.4a | 8.5a | 13.5c | 16.0d | 1.80 |
| JUNE 20 | DAY 10 | 21.8b | 15.1a | 16.2a | 19.4b | 33.3c | 3.27 |
| JUNE 22 | DAY 12 | 37.8c | 24.5a | 32.4b | 33.3bc | 47.9d | 4.53 |
| JUNE 27 | DAY 17 | 46.7c | 31.6a | 40.6b | 41.2b | 54.5d | 5.28 |

Values in the same row with different letters are significantly different at the 0.05 probability level

## 5.2 Plant Height

While it was anticipated that some of the treatments might influence plant height, this expectation was not substantiated (Table 14). In two out of four locations, plants from the check (planter) treatment were significantly taller than the rest. At Myslik's, both of the "rake" treatments were about 10 cm. taller than the rest, while at DeBrouwer's, the check plants were the shortest. No clear interpretation can be offered.

Table 14 TYE DRILL MODIFICATIONS 1989
PLANT HEIGHT cm

| COOPERATOR | TREATMENTS 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
|---|---|---|---|---|---|---|
| Rigby | 68.0a | 65.0a | 63.6a | 62.1a | 78.3b | 5.55 |
| DeBrouwer | 73.6a | 75.4a | 73.9a | 77.4b | 81.5c | 1.85 |
| Groenewegen | 70.9a | 76.4b | 75.8b | 86.5c | 87.5c | 4.04 |
| Myslik | 64.5b | 65.8b | 54.3a | 56.3a | 56.0a | 2.40 |
| Cumming | n/a | n/a | n/a | n/a | n/a | n/a |

Values in the same row with different letters are significantly different at the 0.05 probability level

## 5.3 Pod count and Plant Disease

It was thought that treatments might influence the number of axils setting three or more pods which would affect yields significantly (Table 15).

Table 15 TYE DRILL MODIFICATIONS 1989
POD COUNT/$m^2$
(axils with 3 pods or more)

| COOPERATOR | TREATMENTS 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
|---|---|---|---|---|---|---|
| Rigby | 45.8b | 52.7e | 49.0c | 49.8d | 45.1a | 0.20 |
| DeBrouwer | 55.8b | 72.8d | 52.9a | 66.4c | 52.4c | 2.23 |
| Groenewegen | 61.4c | 63.4c | 47.6b | 46.8b | 42.7a | 3.84 |
| Myslik | 30.5c | 37.5e | 35.9d | 28.5b | 24.9a | 1.06 |
| Cumming | n/a | n/a | n/a | n/a | n/a | n/a |

Values in the same row with different letters are significantly different at the 0.05 probability level

In every location pod counts were highest with the rake treatments - which again is extremely hard to interpret and should be deemed inconclusive.

There was little evidence of root rot except at the Groenewegen plots, where a noticeable number of plants were affected, resulting in stunted growth and arrested pod development (Table 16). At this site, the planter treatment, with a row width of 25 inches (64 cm), had significantly less disease incidence than any of the other treatments.

Table 16 TYE DRILL MODIFICATIONS 1989
ROOT ROT - DISEASED PLANTS / $m^2$

| | TREATMENTS | | | | | |
|---|---|---|---|---|---|---|
| COOPERATOR | 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
| Groenewegen | 2.45b | 2.80b | 2.45b | 3.28b | 0.40a | 1.95 |
| Myslik | 0.4 | 0 | 0.825 | 0 | 0.575 | N.S. 0.49 |

Values in the same row with different letters are significantly different at the 0.05 probability level

## 5.4 Yields

The 1989 yield data do not allow specific conclusions. In three out of five sites, the planter (check) yields were significantly greater than any of the other four treatments cooperator (Table 17). There was no consistent yield difference that could be related to one of the four Tye drill treatments.

Single degree of freedom comparisons, such as rake versus no-rake, single versus double presswheel, do not support definite

conclusions with respect to method of soybean planting using the Tye drill.

Table 17 TYE DRILL MODIFICATIONS 1989
YIELDS - BU/A

| COOPERATOR | TREATMENTS 1 RAKE SINGLE | 2 RAKE DOUBLE | 3 NO-RAKE SINGLE | 4 NO-RAKE DOUBLE | 5 PLANTER | F VALUE |
|---|---|---|---|---|---|---|
| Rigby | 43.2b | 41.9b | 31.1a | 36.0a | 51.8b | 9.45 |
| DeBrouwer | 49.5a | 48.3a | 48.4a | 45.5a | 54.8b | 4.67 |
| Groenewegen | 46.8a | 49.4b | 51.9c | 51.7c | 50.0b | 1.17 |
| Myslik | 28.8b | 30.6c | 26.4a | 29.5b | 33.0d | 1.18 |
| Cumming | 44.4a | 43.5a | 42.3a | 41.0a | 50.7b | 4.96 |

Values in the same row with different letters are significantly different at the 0.05 probability level

## 5.5 General Observations (Year 2)

The season was relatively "normal", compared to the drought of 1988, but was fairly dry during July, August and September (Table 4). Only 30 mm of precipitation fell in July, while about 50 mm fell in August and 60 mm in September. We suspect that with these dry conditions, our fields offered plants little moisture reserves to draw on.

Four out of five sites were planted in quite good time. Myslik's plot went in late, but caught up fairly well only to be hit by an early frost, which reduced the yields to about 60% of the yields at the other sites. The other sites had individual minor problems, as could be expected, but not any which would negate the results.

## 6.0 Conclusions and Recommendations

As mentioned previously on several occasions - it is impossible to draw any definite conclusions from the 1989 data. Consistent patterns or trends useful in evaluating the treatments were absent. The Hegie small plot combine had difficulty in picking up all available beans and possibly resulted in some yield losses. It is not certain that such losses were consistent between plots.

Despite apparent visual and physical differences caused by either coulter arrangements, rakes or packer wheels which appeared to change the seedbed environment in a positive fashion, none of the differences were significant on the small plots used in this experiment.

We have learned that seed placement is of utmost importance and minor adjustments to the coulters are suggested. Better seed placement and coverage could be achieved by a combination of improved balance between the front and rear of the Tye drill and/or more pressure up front, achieved by either spring action or weight. Under no circumstances should seeding occur under improper soil conditions; i.e. too wet (moist) a seedbed would destroy any coulter or rake action the machinery was set-up to achieve.

It is suggested that the farm group repeat the 1989 treatments with the minor adjustments suggested above on a limited commercial field scale, using a standard bean combine and weigh wagon in order to better emulate farm practice and to search for treatment differences. Each of the cooperators is in full agreement with these conclusions and would support such an experiment in 1990.

## 6.1 The Farmers' Report

We were disappointed with the results of this study. We had hoped to make the no-till drill perform to our satisfaction so that we could eliminate the need for two separate planters; one to plant soybeans and one to plant small grains. The no-till drill did not perform to our expectations.

The results shown in this report may not reflect an accurate picture of our experience. The yields from the first year may have been biassed toward the grain drill because we found it difficult to keep border row beans out of our sample. In year 2, we corrected this problem by harvesting the border rows first. The no-till drill was inconsistent in its performance across the field, tending to plant too deep as we crested over a hill, causing a reduction in stand in these locations. We positioned our plots in the flat areas of the field to try and reduce our variables, therefore the report doesn't reflect this problem.

This has been a good learning experience for the farmers involved in this project; we now have a better appreciation for the work researchers do.

More work needs to be done and we have ideas that could be pursued. However, we decided it would not be a wise expenditure of funds to carry on this project for a third year.

## 7.0 Appendices

| | |
|---|---|
| Appendix A | Data Files (Year 1) |
| Appendix B | Data Files (Year 2) |
| Appendix C | Photographs of the equipment used in the research |

# APPENDIX A

Data Files ( Year 1 )

Data file **RIGBY4**
Title: TYE DRILL MODIFICATIONS

Function: PRLIST
Data case no. 1 to 57
Without selection

LIST OF VARIABLES

| VAR | TYPE | NAME/DESCRIPTION |
|---|---|---|
| 1 | text 7 | FARMER |
| 2 | numeric | REP NO. |
| 3 | numeric | TREAT NO. |
| 4 | numeric | YIELD BU/A 14% |
| 5 | numeric | D0-PLANTING DAY |
| 6 | numeric | D1-DAYS |
| 7 | numeric | D1 PLANTS/M^2 |
| 8 | numeric | D2-DAYS |
| 9 | numeric | D2 PLANTS/M^2 |
| 10 | numeric | D3-DAYS |
| 11 | numeric | D3 PLANTS/M^2 |
| 12 | numeric | D4-DAYS |
| 13 | numeric | D4 PLANTS/M^2 |
| 14 | numeric | D5-DAYS |
| 15 | numeric | D5 PLANTS/M^2 |
| 16 | numeric | D6-DAYS |
| 17 | numeric | D6 PLANTS/M^2 |
| 18 | numeric | D7-DAYS |
| 19 | numeric | D7 PLANTS/M^2 |
| 20 | numeric | D8-DAY |
| 21 | numeric | D8 PLANTS/M^2 |

Data file RIGBY4
Title: TYE DRILL MODIFICATIONS

. CASE

| NO. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CUMMING | 1 | 1 | | 141 | 152 | 36.7 | 153 | 38.3 | 154 | 44.4 | 156 | 44.4 | 158 | 56.1 | 160 | 58.9 | 162 | 60.0 | 169 | 57.2 |
| 2 | CUMMING | 1 | 2 | 55.4 | 141 | 152 | 21.7 | 153 | 23.3 | 154 | 28.9 | 156 | 33.9 | 158 | 37.8 | 160 | 38.9 | 162 | 40.6 | 169 | 40.6 |
| 3 | CUMMING | 1 | 3 | 48.6 | 141 | 152 | 13.3 | 153 | 18.9 | 154 | 30.2 | 156 | 33.7 | 158 | 35.1 | 160 | 37.2 | 162 | 37.9 | 169 | 37.9 |
| 4 | CUMMING | 2 | 1 | 53.6 | 141 | 152 | 48.3 | 153 | 48.3 | 154 | 51.1 | 156 | 52.8 | 158 | 53.9 | 160 | 54.4 | 162 | 53.3 | 169 | 55.0 |
| 5 | CUMMING | 2 | 2 | 69.5 | 141 | 152 | 46.7 | 153 | 52.2 | 154 | 52.8 | 156 | 56.7 | 158 | 56.7 | 160 | 51.1 | 162 | 57.7 | 169 | 56.7 |
| 6 | CUMMING | 2 | 3 | 44.2 | 141 | 152 | 28.1 | 153 | 31.6 | 154 | 30.9 | 156 | 33.0 | 158 | 34.4 | 160 | 35.1 | 162 | 35.8 | 169 | 35.8 |
| 7 | CUMMING | 3 | 1 | 57.2 | 141 | 152 | 25.0 | 153 | 30.0 | 154 | 36.7 | 156 | 41.1 | 158 | 43.9 | 160 | 42.2 | 162 | 40.0 | 169 | 45.0 |
| 8 | CUMMING | 3 | 2 | 39.3 | 141 | 152 | 26.1 | 153 | 33.3 | 154 | 36.7 | 156 | 38.3 | 158 | 42.2 | 160 | 45.0 | 162 | 46.7 | 169 | 46.7 |
| 9 | CUMMING | 3 | 3 | 39.4 | 141 | 152 | 18.2 | 153 | 22.4 | 154 | 26.7 | 156 | 31.6 | 158 | 35.8 | 160 | 37.2 | 162 | 38.6 | 169 | 38.6 |
| 10 | CUMMING | 4 | 1 | 65.4 | 141 | 152 | 20.6 | 153 | 26.7 | 154 | 36.1 | 156 | 46.1 | 158 | 48.9 | 160 | 50.6 | 162 | 49.4 | 169 | 51.7 |
| 11 | CUMMING | 4 | 2 | 60.9 | 141 | 152 | 41.1 | 153 | 52.2 | 154 | 55.6 | 156 | 60.0 | 158 | 61.7 | 160 | 63.3 | 162 | 62.8 | 169 | 61.7 |
| 12 | CUMMING | 4 | 3 | 41.7 | 141 | 152 | 12.6 | 153 | 17.5 | 154 | 23.9 | 156 | 26.7 | 158 | 29.5 | 160 | 31.6 | 162 | 32.3 | 169 | 31.6 |
| 13 | HENRY | 1 | 1 | 58.9 | 132 | 142 | 2.8 | 143 | 14.4 | 144 | 22.2 | 146 | 26.7 | 148 | 32.8 | 151 | 40.6 | 153 | 41.7 | 169 | 45.6 |
| 14 | HENRY | 1 | 2 | 65.1 | 132 | 142 | 3.9 | 143 | 9.4 | 144 | 22.8 | 146 | 16.1 | 148 | 33.9 | 151 | 37.8 | 153 | 37.8 | 169 | 41.1 |
| 15 | HENRY | 1 | 3 | 47.8 | 132 | 142 | 8.6 | 143 | 16.5 | 144 | 30.6 | 146 | 34.5 | 148 | 36.9 | 151 | 40.0 | 153 | 41.6 | 169 | 41.6 |
| 16 | HENRY | 2 | 1 | 68.0 | 132 | 142 | 3.9 | 143 | 5.6 | 144 | 8.9 | 146 | 10.6 | 148 | 21.7 | 151 | 30.6 | 153 | 32.8 | 169 | 31.7 |
| 17 | HENRY | 2 | 2 | 59.6 | 132 | 142 | 2.8 | 143 | 6.7 | 144 | 12.8 | 146 | 13.9 | 148 | 23.3 | 151 | 30.0 | 153 | 32.2 | 169 | 37.2 |
| 18 | HENRY | 2 | 3 | 47.0 | 132 | 142 | 10.2 | 143 | 14.1 | 144 | 17.3 | 146 | 17.3 | 148 | 20.4 | 151 | 22.0 | 153 | 21.2 | 169 | 22.0 |
| 19 | HENRY | 3 | 1 | 61.3 | 132 | 142 | 3.9 | 143 | 3.9 | 144 | 8.9 | 146 | 8.9 | 148 | 16.1 | 151 | 18.9 | 153 | 18.9 | 169 | 25.6 |
| 20 | HENRY | 3 | 2 | 60.4 | 132 | 142 | 5.0 | 143 | 8.9 | 144 | 11.1 | 146 | 12.8 | 148 | 18.3 | 151 | 24.4 | 153 | 31.1 | 169 | 25.6 |
| 21 | HENRY | 3 | 3 | 50.7 | 132 | 142 | 7.8 | 143 | 13.3 | 144 | 21.2 | 146 | 20.4 | 148 | 31.4 | 151 | 32.9 | 153 | 30.6 | 169 | 33.7 |
| 22 | HENRY | 4 | 1 | 61.5 | 132 | 142 | 3.9 | 143 | 6.7 | 144 | 17.8 | 146 | 21.1 | 148 | 28.3 | 151 | 30.6 | 153 | 32.8 | 169 | 33.3 |
| 23 | HENRY | 4 | 2 | 54.3 | 132 | 142 | 3.9 | 143 | 10.6 | 144 | 22.2 | 146 | 23.3 | 148 | 33.3 | 151 | 42.2 | 153 | 43.9 | 169 | 46.7 |
| 24 | HENRY | 4 | 3 | 55.9 | 132 | 142 | 11.0 | 143 | 14.9 | 144 | 28.2 | 146 | 32.2 | 148 | 40.8 | 151 | 42.4 | 153 | 43.1 | 169 | 39.2 |
| 25 | HUFFMAN | 1 | 1 | 59.7 | 144 | 152 | 43.3 | 153 | 48.9 | 154 | 56.1 | 156 | 66.1 | 158 | 70.0 | 160 | 71.1 | 162 | 70.0 | 169 | 70.6 |
| 26 | HUFFMAN | 1 | 2 | 60.0 | 144 | 152 | 36.7 | 153 | 45.6 | 154 | 51.7 | 156 | 56.7 | 158 | 62.8 | 160 | 63.3 | 162 | 63.3 | 169 | 63.9 |
| 27 | HUFFMAN | 1 | 3 | 38.2 | 144 | 152 | 48.4 | 153 | 50.5 | 154 | 50.5 | 156 | 52.6 | 158 | 54.0 | 160 | 54.7 | 162 | 55.4 | 169 | 54.0 |
| 28 | HUFFMAN | 2 | 1 | 48.2 | 144 | 152 | 46.1 | 153 | 61.7 | 154 | 72.8 | 156 | 81.7 | 158 | 83.9 | 160 | 87.8 | 162 | 87.8 | 169 | 87.8 |
| 29 | HUFFMAN | 2 | 2 | 40.8 | 144 | 152 | 55.6 | 153 | 63.3 | 154 | 67.2 | 156 | 72.2 | 158 | 74.4 | 160 | 79.4 | 162 | 81.1 | 169 | 81.1 |
| 30 | HUFFMAN | 2 | 3 | 41.1 | 144 | 152 | 45.6 | 153 | 51.2 | 154 | 54.7 | 156 | 56.1 | 158 | 56.1 | 160 | 56.1 | 162 | 56.1 | 169 | 55.4 |
| 31 | HUFFMAN | 3 | 1 | 49.2 | 144 | 152 | 31.7 | 153 | 36.7 | 154 | 48.3 | 156 | 58.9 | 158 | 66.7 | 160 | 66.7 | 162 | 67.8 | 169 | 68.3 |
| 32 | HUFFMAN | 3 | 2 | 51.9 | 144 | 152 | 53.3 | 153 | 55.6 | 154 | 62.8 | 156 | 71.7 | 158 | 73.3 | 160 | 73.9 | 162 | 74.4 | 169 | 73.9 |
| 33 | HUFFMAN | 3 | 3 | 42.7 | 144 | 152 | 45.6 | 153 | 51.2 | 154 | 38.6 | 156 | 54.7 | 158 | 55.4 | 160 | 54.0 | 162 | 54.0 | 169 | 51.9 |
| 34 | HUFFMAN | 4 | 1 | 55.9 | 144 | 152 | 41.7 | 153 | 48.9 | 154 | 53.9 | 156 | 61.1 | 158 | 61.1 | 160 | 66.7 | 162 | 68.9 | 169 | 65.0 |
| 35 | HUFFMAN | 4 | 2 | 43.1 | 144 | 152 | 57.8 | 153 | 65.0 | 154 | 68.9 | 156 | 81.1 | 158 | 83.9 | 160 | 83.3 | 162 | 82.2 | 169 | 79.4 |
| 36 | HUFFMAN | 4 | 3 | 41.6 | 144 | 152 | 27.4 | 153 | 35.1 | 154 | 44.2 | 156 | 45.6 | 158 | 52.6 | 160 | 53.3 | 162 | 53.3 | 169 | 54.0 |
| 37 | MYSLIK | 1 | 1 | 63.2 | 134 | 145 | 4.4 | 147 | 17.8 | 149 | 27.2 | 151 | 27.8 | 153 | 30.0 | 155 | 29.4 | 162 | 30.6 | 169 | 28.9 |
| 38 | MYSLIK | 1 | 2 | 56.1 | 134 | 145 | 0.6 | 147 | 2.8 | 149 | 8.3 | 151 | 13.3 | 153 | 18.3 | 155 | 21.1 | 162 | 23.3 | 169 | 24.4 |
| 39 | MYSLIK | 1 | 3 | 31.1 | 134 | 145 | 4.2 | 147 | 7.7 | 149 | 21.8 | 151 | 23.2 | 153 | 23.9 | 155 | 24.6 | 162 | 23.9 | 169 | 22.5 |
| 40 | MYSLIK | 2 | 1 | 43.8 | 134 | 145 | 12.2 | 147 | 15.6 | 149 | 23.9 | 151 | 21.7 | 153 | 23.3 | 155 | 22.8 | 162 | 23.9 | 169 | 24.4 |
| 41 | MYSLIK | 2 | 2 | 85.8 | 134 | 145 | 9.4 | 147 | 12.2 | 149 | 20.6 | 151 | 22.8 | 153 | 23.3 | 155 | 25.6 | 162 | 25.6 | 169 | 25.0 |
| 42 | MYSLIK | 2 | 3 | 26.7 | 134 | 145 | 0.0 | 147 | 0.0 | 149 | 6.3 | 151 | 9.8 | 153 | 16.1 | 155 | 16.1 | 162 | 16.8 | 169 | 18.2 |
| 43 | MYSLIK | 3 | 1 | 52.3 | 134 | 145 | 16.1 | 147 | 34.4 | 149 | 38.3 | 151 | 41.1 | 153 | 41.7 | 155 | 41.7 | 162 | 41.1 | 169 | 40.6 |
| 44 | MYSLIK | 3 | 2 | 30.0 | 134 | 145 | 2.2 | 147 | 5.0 | 149 | 15.0 | 151 | 18.9 | 153 | 22.2 | 155 | 22.8 | 162 | 23.3 | 169 | 23.9 |
| 45 | MYSLIK | 3 | 3 | 13.6 | 134 | 145 | 0.0 | 147 | 1.4 | 149 | 4.2 | 151 | 7.7 | 153 | 15.4 | 155 | 16.1 | 162 | 17.5 | 169 | 15.4 |
| 46 | RIGBY | 1 | 1 | 60.4 | 134 | 145 | 8.3 | 147 | 16.7 | 149 | 27.8 | 151 | 20.0 | 153 | 17.8 | 155 | 20.0 | 162 | 22.2 | 169 | 21.7 |
| 47 | RIGBY | 1 | 2 | 46.5 | 134 | 145 | 3.3 | 147 | 4.4 | 149 | 15.0 | 151 | 23.3 | 153 | 17.2 | 155 | 20.0 | 162 | 20.0 | 169 | 21.1 |
| 48 | RIGBY | 1 | 3 | 70.6 | 134 | 145 | 6.3 | 147 | 11.8 | 149 | 23.5 | 151 | 22.0 | 153 | 22.0 | 155 | 22.0 | 162 | 22.0 | 169 | 22.0 |
| 49 | RIGBY | 2 | 1 | 62.7 | 134 | 145 | 7.2 | 147 | 14.4 | 149 | 18.3 | 151 | 17.2 | 153 | 19.4 | 155 | 20.6 | 162 | 23.9 | 169 | 27.2 |
| 50 | RIGBY | 2 | 2 | 57.6 | 134 | 145 | 3.9 | 147 | 5.6 | 149 | 7.8 | 151 | 8.3 | 153 | 12.8 | 155 | 13.3 | 162 | 12.2 | 169 | 11.7 |
| 51 | RIGBY | 2 | 3 | 35.6 | 134 | 145 | 1.6 | 147 | 7.1 | 149 | 14.1 | 151 | 13.3 | 153 | 19.6 | 155 | 21.2 | 162 | 21.2 | 169 | 22.7 |
| 52 | RIGBY | 3 | 1 | 57.6 | 134 | 145 | 5.0 | 147 | 7.8 | 149 | 11.7 | 151 | 15.5 | 153 | 17.2 | 155 | 17.8 | 162 | 18.3 | 169 | 17.8 |
| 53 | RIGBY | 3 | 2 | 56.6 | 134 | 145 | 7.8 | 147 | 11.1 | 149 | 14.4 | 151 | 13.9 | 153 | 19.4 | 155 | 22.2 | 162 | 21.7 | 169 | 21.1 |
| 54 | RIGBY | 3 | 3 | 56.7 | 134 | 145 | 3.1 | 147 | 7.1 | 149 | 20.4 | 151 | 23.5 | 153 | 24.3 | 155 | 23.5 | 162 | 24.3 | 169 | 23.5 |

Data file RIGBY4
Title: TYE DRILL MODIFICATIONS

| CASE NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55 | RIGBY | 4 | 1 | 61.7 | 134 | 145 | 5.6 | 147 | 8.3 | 149 | 11.1 | 151 | 15.6 | 153 | 17.8 | 155 | 18.9 | 162 | 21.1 | 169 | 21.1 | |
| 56 | RIGBY | 4 | 2 | 49.9 | 134 | 145 | 5.0 | 147 | 7.8 | 149 | 19.4 | 151 | 18.3 | 153 | 23.3 | 155 | 25.0 | 162 | 27.2 | 169 | 26.7 | |
| 57 | RIGBY | 4 | 3 | 61.4 | 134 | 145 | 5.5 | 147 | 13.3 | 149 | 30.6 | 151 | 34.5 | 153 | 33.7 | 155 | 33.7 | 162 | 33.7 | 169 | 32.9 | |

# APPENDIX B

Data Files ( Year 2 )

Data file RIGBY189
Title: TYE DRILL MODIFICATIONS

Function: PRLIST
Data case no. 1 to 20
Without selection

LIST OF VARIABLES

| VAR | TYPE | NAME/DESCRIPTION |
|---|---|---|
| 1 | text 7 | FARMER |
| 2 | numeric | REP NO. |
| 3 | numeric | TREAT NO. |
| 4 | numeric | YIELD BU/A 14% |
| 5 | numeric | D0-PLANTING DAY |
| 6 | numeric | D1-DAYS |
| 7 | numeric | D1 PLANTS/M^2 |
| 8 | numeric | D2-DAYS |
| 9 | numeric | D2 PLANTS/M^2 |
| 10 | numeric | D3-DAYS |
| 11 | numeric | D3 PLANTS/M^2 |
| 12 | numeric | D4-DAYS |
| 13 | numeric | D4 PLANTS/M^2 |
| 14 | numeric | D5-DAYS |
| 15 | numeric | D5 PLANTS/M^2 |
| 16 | numeric | D6-DAYS |
| 17 | numeric | D6 PLANTS/M^2 |
| 18 | numeric | HEIGHT CM |
| 19 | numeric | POPULATION PLANTS/M^2 |
| 20 | numeric | ROOT ROT DISEASED PLTS/M^2 |
| 21 | numeric | PODS NO./M^2 |
| 22 | numeric | SEED WEIGHTS (100 SEEDS) GRAMS |

| CASE NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | RIGBY | 1 | 1 | 0.0 | 149 | 156 | 1.1 | 159 | 1.6 | 161 | 7.5 | 164 | 26.9 | 167 | 44.7 | 172 | 51.1 | 62.7 | 32.8 | 0.0 | | 43.5 | 15.61 |
| 2 | RIGBY | 1 | 2 | 0.0 | 149 | 152 | 0.0 | 159 | 0.0 | 161 | 1.1 | 164 | 9.1 | 167 | 21.0 | 172 | 31.2 | 66.7 | 31.1 | 0.0 | | 49.2 | 15.33 |
| 3 | RIGBY | 1 | 3 | 0.0 | 149 | 158 | 0.5 | 159 | 1.1 | 161 | 2.7 | 164 | 8.1 | 167 | 24.8 | 172 | 34.4 | 67.7 | 29.5 | 0.0 | | 31.2 | 15.79 |
| 4 | RIGBY | 1 | 4 | 0.0 | 149 | 158 | 0.0 | 159 | 2.2 | 161 | 6.7 | 164 | 15.1 | 167 | 31.2 | 172 | 36.6 | 64.7 | 32.8 | 0.0 | | 50.0 | 15.10 |
| 5 | RIGBY | 1 | 5 | 0.0 | 149 | 156 | 0.0 | 159 | 3.8 | 161 | 21.3 | 164 | 44.8 | 167 | 71.4 | 172 | 68.4 | 66.0 | 48.6 | 0.0 | | 28.9 | 16.17 |
| 6 | RIGBY | 2 | 1 | 42.1 | 149 | 158 | 1.1 | 159 | 1.6 | 161 | 1.6 | 164 | 16.1 | 167 | 38.8 | 172 | 50.6 | 70.3 | 23.0 | 0.0 | | 38.6 | 15.74 |
| 7 | RIGBY | 2 | 2 | 36.2 | 149 | 158 | 0.0 | 159 | 0.0 | 161 | 0.5 | 164 | 2.2 | 167 | 12.4 | 172 | 33.4 | 63.7 | 29.5 | 0.0 | | 52.5 | 14.73 |
| 8 | RIGBY | 2 | 3 | 38.9 | 149 | 158 | 0.0 | 159 | 1.6 | 161 | 3.8 | 164 | 9.7 | 167 | 26.4 | 172 | 35.5 | 58.3 | 31.1 | 0.0 | | 49.2 | 15.45 |
| 9 | RIGBY | 2 | 4 | 29.9 | 149 | 158 | 0.0 | 159 | 0.0 | 161 | 0.0 | 164 | 0.5 | 167 | 6.5 | 172 | 19.9 | 60.0 | 26.2 | 0.0 | | 41.9 | 15.07 |
| 10 | RIGBY | 2 | 5 | 46.5 | 149 | 158 | 2.3 | 159 | 11.4 | 161 | 32.7 | 164 | 51.7 | 167 | 63.1 | 172 | 62.3 | 87.0 | 53.2 | 0.0 | | 79.6 | 14.76 |
| 11 | RIGBY | 3 | 1 | 43.9 | 149 | 158 | 0.0 | 159 | 0.0 | 161 | 0.5 | 164 | 0.5 | 167 | 5.4 | 172 | 22.6 | 70.0 | 31.1 | 0.0 | | 55.0 | 15.27 |
| 12 | RIGBY | 3 | 2 | 44.0 | 149 | 158 | 0.0 | 159 | 2.2 | 161 | 8.1 | 164 | 12.9 | 167 | 32.3 | 172 | 38.9 | 62.0 | 42.6 | 0.0 | | 43.5 | 16.08 |
| 13 | RIGBY | 3 | 3 | 31.0 | 149 | 156 | 0.0 | 159 | 0.0 | 161 | 0.0 | 164 | 2.7 | 167 | 5.9 | 172 | 9.7 | 64.0 | 41.9 | 0.0 | | 49.2 | 16.07 |
| 14 | RIGBY | 3 | 4 | 40.9 | 149 | 158 | 0.0 | 159 | 0.5 | 161 | 2.2 | 164 | 9.7 | 167 | 29.9 | 172 | 39.8 | 66.0 | 32.8 | 0.0 | | 62.3 | 15.37 |
| 15 | RIGBY | 3 | 5 | 58.2 | 149 | 158 | 0.8 | 159 | 5.3 | 161 | 19.8 | 164 | 50.2 | 167 | 72.2 | 172 | 75.2 | 80.0 | 50.9 | 0.0 | | 56.7 | 17.49 |
| 16 | RIGBY | 4 | 1 | 43.7 | 149 | 158 | 0.5 | 159 | 1.6 | 161 | 3.2 | 164 | 8.1 | 167 | 24.2 | 172 | 40.9 | 69.0 | 39.3 | 0.0 | | 45.9 | 15.82 |
| 17 | RIGBY | 4 | 2 | 45.4 | 149 | 158 | 0.0 | 159 | 1.6 | 161 | 2.2 | 164 | 4.8 | 167 | 21.5 | 172 | 35.0 | 67.7 | 41.0 | 0.0 | | 65.6 | 15.19 |
| 18 | RIGBY | 4 | 3 | 26.3 | 149 | 158 | 0.0 | 159 | 0.0 | 161 | 0.0 | 164 | 1.1 | 167 | 13.5 | 172 | 20.5 | 64.3 | 29.5 | 0.0 | | 66.4 | 15.62 |
| 19 | RIGBY | 4 | 4 | 37.3 | 149 | 158 | 0.0 | 159 | 0.0 | 161 | 0.0 | 164 | 0.5 | 167 | 4.3 | 172 | 17.2 | 57.7 | 18.0 | 0.0 | | 45.9 | 14.86 |
| 20 | RIGBY | 4 | 5 | 50.6 | 149 | 156 | 0.8 | 159 | 2.3 | 161 | 14.4 | 164 | 35.0 | 167 | 54.7 | 172 | 57.0 | 80.0 | 53.2 | 2.3 | | 24.3 | 16.28 |

Data file RIGBY184
Title: TYE DRILL MODIFICATIONS

Function: FRLIST
Data case no. 21 to 70
Without selection

| CASE NO. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | DEBROUW | 1 | 1 | 49.7 | 149 | 158 | 23.7 | 159 | 30.7 | 161 | 43.1 | 164 | 51.7 | 167 | 64.0 | 172 | 63.0 | 81.0 | 54.1 | 0.0 | 95.2 | 16.98 |
| 22 | DEBROUW | 1 | 2 | 47.9 | 149 | 158 | 14.0 | 159 | 28.0 | 161 | 35.5 | 164 | 40.4 | 167 | 47.9 | 172 | 51.1 | 73.7 | 37.7 | 0.0 | 117.3 | 16.41 |
| 23 | DEBROUW | 1 | 3 | 46.7 | 149 | 158 | 3.2 | 159 | 7.0 | 161 | 17.8 | 164 | 30.1 | 167 | 47.9 | 172 | 50.1 | 82.0 | 47.5 | 0.0 | 91.9 | 15.78 |
| 24 | DEBROUW | 1 | 4 | 44.1 | 149 | 158 | 6.5 | 159 | 18.8 | 161 | 24.8 | 164 | 33.9 | 167 | 47.4 | 172 | 52.7 | 90.0 | 41.0 | 0.0 | 94.3 | 17.64 |
| 25 | DEBROUW | 1 | 5 | 56.3 | 149 | 158 | 2.3 | 159 | 16.7 | 161 | 29.6 | 164 | 64.6 | 167 | 81.3 | 172 | 81.3 | 85.0 | 39.4 | 2.3 | 61.3 | 17.00 |
| 26 | DEBROUW | 2 | 1 | 54.3 | 149 | 158 | 2.7 | 159 | 8.1 | 161 | 16.7 | 164 | 26.9 | 167 | 45.2 | 172 | 53.8 | 93.7 | 39.3 | 1.6 | 52.5 | 15.9e |
| 27 | DEBROUW | 2 | 2 | 50.9 | 149 | 158 | 12.9 | 159 | 22.1 | 161 | 33.9 | 164 | 41.4 | 167 | 46.8 | 172 | 50.1 | 87.7 | 36.1 | 0.0 | 48.4 | 18.54 |
| 28 | DEBROUW | 2 | 3 | 47.4 | 149 | 158 | 32.8 | 159 | 40.9 | 161 | 50.1 | 164 | 54.4 | 167 | 57.1 | 172 | 57.6 | 90.0 | 41.0 | 0.0 | 52.5 | 20.70 |
| 29 | DEBROUW | 2 | 4 | 49.4 | 149 | 158 | 11.9 | 159 | 17.8 | 161 | 28.5 | 164 | 36.1 | 167 | 39.3 | 172 | 40.9 | 93.7 | 31.1 | 0.0 | 64.8 | 16.40 |
| 30 | DEBROUW | 2 | 5 | 55.8 | 149 | 158 | 42.6 | 159 | 59.3 | 161 | 75.2 | 164 | 88.1 | 167 | 91.9 | 172 | 89.7 | 90.0 | 74.1 | 0.0 | 61.3 | 16.41 |
| 31 | DEBROUW | 3 | 1 | 44.4 | 149 | 158 | 14.5 | 159 | 21.5 | 161 | 30.1 | 164 | 43.1 | 167 | 54.4 | 172 | 58.1 | 66.7 | 52.5 | 0.0 | 28.7 | 18.49 |
| 32 | DEBROUW | 3 | 2 | 46.1 | 149 | 158 | 10.2 | 159 | 23.7 | 161 | 31.8 | 164 | 37.7 | 167 | 47.4 | 172 | 50.1 | 73.3 | 45.9 | 0.0 | 64.9 | 16.99 |
| 33 | DEBROUW | 3 | 3 | 51.1 | 149 | 158 | 11.3 | 159 | 19.9 | 161 | 27.4 | 164 | 29.1 | 167 | 49.5 | 172 | 54.9 | 60.7 | 27.9 | 0.0 | 25.4 | 16.88 |
| 34 | DEBROUW | 3 | 4 | 43.0 | 149 | 158 | 12.9 | 159 | 24.8 | 161 | 36.1 | 164 | 46.3 | 167 | 50.6 | 172 | 52.2 | 66.0 | 27.9 | 0.0 | 50.0 | 17.76 |
| 35 | DEBROUW | 3 | 5 | 52.4 | 149 | 158 | 30.4 | 159 | 40.3 | 161 | 51.7 | 164 | 60.0 | 167 | 66.1 | 172 | 67.6 | 78.0 | 53.2 | 0.0 | 33.6 | 16.74 |
| 36 | DEBROUW | 4 | 1 | 0.0 | 149 | 158 | 12.9 | 159 | 17.8 | 161 | 26.4 | 164 | 28.0 | 167 | 42.5 | 172 | 50.1 | 63.0 | 32.8 | 0.0 | 46.8 | 17.14 |
| 37 | DEBROUW | 4 | 2 | 0.0 | 149 | 158 | 10.2 | 159 | 18.8 | 161 | 34.4 | 164 | 39.3 | 167 | 46.8 | 172 | 48.4 | 66.7 | 44.3 | 0.0 | 60.7 | 17.31 |
| 38 | DEBROUW | 4 | 3 | 0.0 | 149 | 158 | 22.6 | 159 | 32.8 | 161 | 40.1 | 164 | 46.8 | 167 | 54.4 | 172 | 57.1 | 63.0 | 57.4 | 3.3 | 41.8 | 17.78 |
| 39 | DEBROUW | 4 | 4 | 0.0 | 149 | 158 | 10.2 | 159 | 17.8 | 161 | 28.5 | 164 | 38.8 | 167 | 43.1 | 172 | 49.0 | 70.0 | 47.5 | 0.0 | 56.6 | 17.26 |
| 40 | DEBROUW | 4 | 5 | 0.0 | 149 | 158 | 29.6 | 159 | 38.0 | 161 | 44.8 | 164 | 47.9 | 167 | 47.9 | 172 | 55.5 | 73.0 | 46.3 | 0.0 | 53.2 | 16.71 |
| 41 | GROENEW | 1 | 1 | 47.3 | 150 | 158 | 3.2 | 159 | 4.8 | 161 | 8.6 | 164 | 25.8 | 167 | 49.0 | 173 | 55.4 | 78.7 | 50.8 | 3.3 | 61.5 | 18.41 |
| 42 | GROENEW | 1 | 2 | 52.3 | 150 | 158 | 21.0 | 159 | 34.4 | 161 | 39.3 | 164 | 57.1 | 167 | 67.3 | 173 | 68.9 | 78.7 | 55.7 | 3.3 | 59.1 | 17.78 |
| 43 | GROENEW | 1 | 3 | 49.2 | 150 | 158 | 14.5 | 159 | 21.0 | 161 | 36.6 | 164 | 50.1 | 167 | 63.5 | 173 | 65.7 | 72.3 | 65.6 | 4.9 | 39.4 | 18.46 |
| 44 | GROENEW | 1 | 4 | 51.6 | 150 | 158 | 20.5 | 159 | 24.8 | 161 | 36.6 | 164 | 45.2 | 167 | 60.8 | 173 | 67.8 | 76.0 | 63.9 | 4.9 | 46.8 | 17.98 |
| 45 | GROENEW | 1 | 5 | 50.1 | 150 | 158 | 17.1 | 159 | 27.9 | 161 | 38.8 | 164 | 55.8 | 167 | 64.1 | 173 | 65.1 | 83.0 | 56.7 | 0.0 | 44.1 | 17.12 |
| 46 | GROENEW | 2 | 1 | 51.3 | 150 | 158 | 1.6 | 159 | 5.4 | 161 | 8.6 | 164 | 20.5 | 167 | 45.7 | 173 | 51.7 | 70.0 | 60.7 | 4.9 | 56.6 | 17.90 |
| 47 | GROENEW | 2 | 2 | 50.8 | 150 | 158 | 7.5 | 159 | 14.5 | 161 | 31.8 | 164 | 40.4 | 167 | 52.7 | 173 | 54.4 | 76.7 | 54.1 | 1.6 | 66.4 | 16.65 |
| 48 | GROENEW | 2 | 3 | 49.3 | 150 | 158 | 3.8 | 159 | 4.3 | 161 | 16.7 | 164 | 31.2 | 167 | 49.5 | 173 | 56.0 | 65.0 | 54.1 | 3.3 | 31.2 | 16.93 |
| 49 | GROENEW | 2 | 4 | 51.5 | 150 | 158 | 13.5 | 159 | 20.5 | 161 | 25.3 | 164 | 37.7 | 167 | 51.5 | 173 | 52.7 | 82.0 | 62.3 | 4.9 | 52.5 | 17.83 |
| 50 | GROENEW | 2 | 5 | 55.2 | 150 | 158 | 18.1 | 159 | 32.6 | 161 | 40.3 | 164 | 51.7 | 167 | 57.4 | 173 | 57.9 | 80.0 | 56.7 | 0.0 | 32.3 | 15.0e |
| 51 | GROENEW | 3 | 1 | 44.7 | 150 | 158 | 0.0 | 159 | 0.0 | 161 | 2.7 | 164 | 12.9 | 167 | 24.8 | 173 | 29.6 | 73.0 | 34.4 | 0.0 | 69.7 | 17.72 |
| 52 | GROENEW | 3 | 2 | 49.6 | 150 | 158 | 2.2 | 159 | 7.5 | 161 | 21.0 | 164 | 38.2 | 167 | 46.3 | 173 | 49.5 | 71.7 | 29.5 | 3.0 | 55.8 | 18.09 |
| 53 | GROENEW | 3 | 3 | 49.0 | 150 | 158 | 9.7 | 159 | 17.8 | 161 | 25.8 | 164 | 32.3 | 167 | 54.4 | 173 | 58.1 | 79.3 | 42.6 | 0.0 | 50.0 | 17.66 |
| 54 | GROENEW | 3 | 4 | 51.5 | 150 | 158 | 11.8 | 159 | 24.8 | 161 | 32.8 | 164 | 41.4 | 167 | 53.8 | 173 | 53.8 | 91.7 | 49.2 | 0.0 | 50.0 | 17.55 |
| 55 | GROENEW | 3 | 5 | 48.6 | 150 | 158 | 20.2 | 159 | 31.5 | 161 | 53.7 | 164 | 66.7 | 167 | 79.1 | 173 | 80.6 | 90.0 | 47.2 | 1.6 | 55.1 | 17.66 |
| 56 | GROENEW | 4 | 1 | 43.9 | 150 | 158 | 4.3 | 159 | 11.3 | 161 | 18.3 | 164 | 30.7 | 167 | 44.7 | 173 | 46.8 | 61.7 | 41.0 | 1.6 | 78.8 | 19.1e |
| 57 | GROENEW | 4 | 2 | 44.8 | 150 | 158 | 3.8 | 159 | 14.0 | 161 | 26.9 | 164 | 37.7 | 167 | 49.5 | 173 | 49.5 | 78.3 | 36.1 | 3.3 | 72.2 | 18.14 |
| 58 | GROENEW | 4 | 3 | 59.9 | 150 | 158 | 14.5 | 159 | 29.1 | 161 | 45.5 | 164 | 55.4 | 167 | 59.7 | 173 | 60.3 | 86.7 | 37.7 | 1.6 | 69.7 | 17.05 |
| 59 | GROENEW | 4 | 4 | 52.0 | 150 | 158 | 22.1 | 159 | 30.7 | 161 | 42.5 | 164 | 51.1 | 167 | 56.5 | 173 | 56.0 | 96.3 | 55.7 | 3.3 | 37.7 | 18.26 |
| 60 | GROENEW | 4 | 5 | 46.1 | 150 | 158 | 31.5 | 159 | 49.1 | 161 | 58.4 | 164 | 61.0 | 167 | 64.6 | 173 | 64.1 | 96.0 | 53.5 | 0.0 | 39.4 | 17.e7 |
| 61 | MYSLIK | 1 | 1 | 28.4 | 162 | 170 | 50.6 | 171 | 68.9 | 173 | 74.8 | 178 | 77.0 | | | | | 73.0 | 62.3 | 0.0 | 45.1 | 20.37 |
| 62 | MYSLIK | 1 | 2 | 36.3 | 162 | 170 | 28.5 | 171 | 56.0 | 173 | 57.6 | 178 | 59.2 | | | | | 78.7 | 72.9 | 0.0 | 52.5 | 21.13 |
| 63 | MYSLIK | 1 | 3 | 18.7 | 162 | 170 | 10.8 | 171 | 33.9 | 173 | 60.3 | 178 | 60.3 | | | | | 50.0 | 75.4 | 0.0 | 47.6 | 19.06 |
| 64 | MYSLIK | 1 | 4 | 34.9 | 162 | 170 | 29.1 | 171 | 64.0 | 173 | 65.1 | 178 | 70.5 | | | | | 60.3 | 44.3 | 0.0 | 28.7 | 18.51 |
| 65 | MYSLIK | 1 | 5 | 29.9 | 162 | 170 | 38.1 | 171 | 63.2 | 173 | 79.5 | 178 | 79.5 | | | | | 56.0 | 76.6 | 0.0 | 10.4 | 20.15 |
| 66 | MYSLIK | 2 | 1 | 27.6 | 162 | 170 | 33.9 | 171 | 60.8 | 173 | 71.6 | 178 | 72.1 | | | | | 73.3 | 54.1 | 0.0 | 33.6 | 20.32 |
| 67 | MYSLIK | 2 | 2 | 28.1 | 162 | 170 | 29.1 | 171 | 54.9 | 173 | 61.9 | 178 | 63.5 | | | | | 63.0 | 57.4 | 0.0 | 33.6 | 22.31 |
| 68 | MYSLIK | 2 | 3 | 28.5 | 162 | 170 | 26.4 | 171 | 54.9 | 173 | 60.3 | 178 | 60.8 | | | | | 53.7 | 54.4 | 0.0 | 32.0 | 20.37 |
| 69 | MYSLIK | 2 | 4 | 20.0 | 162 | 170 | 33.4 | 171 | 59.7 | 173 | 65.1 | 178 | 67.3 | | | | | 52.7 | 54.1 | 0.0 | 33.6 | 19.83 |
| 70 | MYSLIK | 2 | 5 | 29.5 | 162 | 170 | 44.9 | 171 | 76.1 | 173 | 84.3 | 178 | 84.3 | | | | | 56.0 | 53.0 | 0.0 | 20.7 | 19.01 |

Data file RIGBY189
Title: TYE DRILL MODIFICATIONS

Function: PRLIST
Data case no. 71 to 100
Without selection

| CASE NO. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 71 | MYSLIK | 3 | 1 | 33.5 | 162 | 170 | 43.6 | 171 | 69.4 | 173 | 72.1 | 178 | 72.7 | | | | | | 62.0 | 68.9 | 0.0 | 22.1 | 20.89 |
| 72 | MYSLIK | 3 | 2 | 32.6 | 162 | 170 | 18.8 | 171 | 56.5 | 173 | 64.0 | 178 | 64.0 | | | | | | 60.0 | 54.5 | 0.0 | 35.3 | 19.48 |
| 73 | MYSLIK | 3 | 3 | 31.8 | 162 | 170 | 19.9 | 171 | 48.4 | 173 | 49.5 | 178 | 51.7 | | | | | | 59.3 | 49.2 | 0.0 | 40.2 | 19.81 |
| 74 | MYSLIK | 3 | 4 | 34.7 | 162 | 170 | 28.0 | 171 | 38.8 | 173 | 46.3 | 178 | 51.1 | | | | | | 58.7 | 41.0 | 0.0 | 34.5 | 20.63 |
| 75 | MYSLIK | 3 | 5 | 37.6 | 162 | 170 | 39.4 | 171 | 56.4 | 173 | 59.8 | 178 | 59.1 | | | | | | 63.0 | 62.1 | 0.0 | 34.2 | 19.20 |
| 76 | MYSLIK | 4 | 1 | 25.7 | 162 | 170 | 41.4 | 171 | 69.4 | 173 | 75.3 | 178 | 76.4 | | | | | | 49.7 | 93.4 | 0.0 | 21.3 | 22.27 |
| 77 | MYSLIK | 4 | 2 | 25.2 | 162 | 170 | 29.6 | 171 | 54.4 | 173 | 56.5 | 178 | 58.1 | | | | | | 61.3 | 62.3 | 0.0 | 28.7 | 20.95 |
| 78 | MYSLIK | 4 | 3 | 26.4 | 162 | 170 | 31.2 | 171 | 52.2 | 173 | 64.0 | 178 | 67.3 | | | | | | 54.3 | 52.5 | 0.0 | 23.8 | 21.71 |
| 79 | MYSLIK | 4 | 4 | 28.3 | 162 | 170 | 12.9 | 171 | 33.4 | 173 | 58.7 | 178 | 63.5 | | | | | | 53.3 | 50.8 | 0.0 | 17.2 | 21.74 |
| 80 | MYSLIK | 4 | 5 | 35.1 | 162 | 170 | 48.9 | 171 | 77.5 | 173 | 79.5 | 178 | 79.5 | | | | | | 55.0 | 60.4 | 0.0 | 34.2 | 19.54 |
| 81 | CUMMING | 1 | 1 | 40.5 | 162 | 170 | 17.2 | 171 | 33.4 | 173 | 45.2 | 178 | 50.1 | | | | | | | | | | 16.00 |
| 82 | CUMMING | 1 | 2 | 46.9 | 162 | 170 | 9.1 | 171 | 17.8 | 173 | 29.6 | 178 | 37.7 | | | | | | | | | | 15.99 |
| 83 | CUMMING | 1 | 3 | 47.3 | 162 | 170 | 14.5 | 171 | 23.7 | 173 | 40.4 | 178 | 45.2 | | | | | | | | | | 16.91 |
| 84 | CUMMING | 1 | 4 | 38.1 | 162 | 170 | 18.3 | 171 | 23.7 | 173 | 37.1 | 178 | 45.2 | | | | | | | | | | 15.61 |
| 85 | CUMMING | 1 | 5 | 46.0 | 162 | 170 | 19.7 | 171 | 34.0 | 173 | 38.7 | 178 | 50.3 | | | | | | | | | | 15.87 |
| 86 | CUMMING | 2 | 1 | 50.6 | 162 | 170 | 4.3 | 171 | 12.4 | 173 | 36.1 | 178 | 46.9 | | | | | | | | | | 16.66 |
| 87 | CUMMING | 2 | 2 | 46.4 | 162 | 170 | 11.3 | 171 | 17.2 | 173 | 23.1 | 178 | 31.2 | | | | | | | | | | 16.34 |
| 88 | CUMMING | 2 | 3 | 41.7 | 162 | 170 | 4.3 | 171 | 8.6 | 173 | 27.4 | 178 | 36.6 | | | | | | | | | | 15.43 |
| 89 | CUMMING | 2 | 4 | 45.1 | 162 | 170 | 10.8 | 171 | 17.8 | 173 | 36.1 | 178 | 46.8 | | | | | | | | | | 16.78 |
| 90 | CUMMING | 2 | 5 | 54.4 | 162 | 170 | 14.3 | 171 | 27.9 | 173 | 52.3 | 178 | 61.2 | | | | | | | | | | 16.86 |
| 91 | CUMMING | 3 | 1 | 41.9 | 162 | 170 | 11.8 | 171 | 17.8 | 173 | 28.5 | 178 | 40.4 | | | | | | | | | | 15.46 |
| 92 | CUMMING | 3 | 2 | 44.5 | 162 | 170 | 7.5 | 171 | 17.8 | 173 | 29.6 | 178 | 35.5 | | | | | | | | | | 16.27 |
| 93 | CUMMING | 3 | 3 | 41.7 | 162 | 170 | 0.5 | 171 | 12.4 | 173 | 27.9 | 178 | 34.4 | | | | | | | | | | 15.13 |
| 94 | CUMMING | 3 | 4 | 43.9 | 162 | 170 | 16.1 | 171 | 25.8 | 173 | 40.9 | 178 | 49.0 | | | | | | | | | | 15.23 |
| 95 | CUMMING | 3 | 5 | 52.0 | 162 | 170 | 23.1 | 171 | 33.0 | 173 | 59.8 | 178 | 59.8 | | | | | | | | | | 16.13 |
| 96 | CUMMING | 4 | 1 | 44.4 | 162 | 170 | 10.8 | 171 | 23.7 | 173 | 41.4 | 178 | 47.4 | | | | | | | | | | 17.91 |
| 97 | CUMMING | 4 | 2 | 36.2 | 162 | 170 | 1.6 | 171 | 7.5 | 173 | 15.6 | 178 | 22.1 | | | | | | | | | | 17.42 |
| 98 | CUMMING | 4 | 3 | 38.4 | 162 | 170 | 14.5 | 171 | 19.9 | 173 | 33.9 | 178 | 46.3 | | | | | | | | | | 16.32 |
| 99 | CUMMING | 4 | 4 | 36.8 | 162 | 170 | 9.6 | 171 | 10.2 | 173 | 19.4 | 178 | 23.7 | | | | | | | | | | 16.97 |
| 100 | CUMMING | 4 | 5 | 48.4 | 162 | 170 | 6.8 | 171 | 12.4 | 173 | 40.8 | 178 | 46.9 | | | | | | | | | | 16.28 |